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THE EFFECTS OF VARYING STIMULUS AND RESPONSE MODALITIES
ON THE SHORT-TERM MEMORY OF CHILDREN

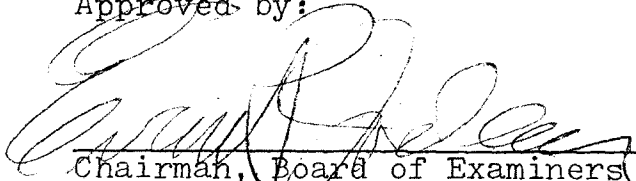
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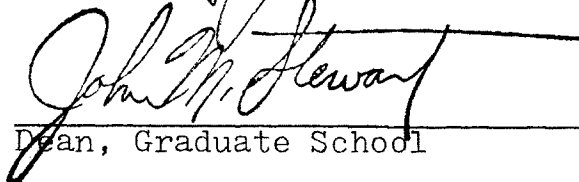
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B.A., University of Montana, 1974

Presented in partial fulfillment of the requirements
for the degree of
Master of Arts
University of Montana
1977

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ABSTRACT

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The Effects of Varying Stimulus and Response Modalities on
the Short-term Memory of Children (43 pp.)

Director: Evan P. Jordan 

The effects of various presentation and response modes on short-term memory was studied in a population of 54 second-graders, half females and half males. The subjects were divided into three groups, the children in each group receiving 3 tests of short-term memory span. Mode of material presentation (auditory, visual, or auditory-visual) remained the same for each group, but the mode of response (oral, gestural, or oral-gestural) was changed for each of the three tests. The effect of test order was evaluated. The subjects were told single words and/or shown corresponding pictures; the stimuli were withdrawn and the children were asked to recall the words and/or find the pictures that they had seen from those now arranged in a larger set of pictures. A three-factor analysis of variance design was used to evaluate the three main effects and four interactions, and Scheffe contrasts were used to make paired comparisons.

The children scored significantly higher when the auditory mode of presentation was used than when the visual or auditory-visual modes were used. Response modality and order did not effect significant differences in the short-term memory scores. The response modes were more effective when combined with the auditory presentation mode than with the visual, and the gestural response mode was significantly better when combined with the auditory presentation mode than with the auditory-visual. Results may have been due to forced verbal labeling differences in test methods, or favored sensory-motor "channels".

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Chapter 1

INTRODUCTION

Review of the Literature

In the last decades a growth of interest in memory and its relation to intellectual functioning and academic abilities has become apparent. Increased study of short-term memory has resulted from this interest and been given impetus by the development of the Illinois Test of Psycholinguistic Abilities (McCarthy and Kirk, 1961).

The importance of memory to verbal learning is commonly recognized by researchers of the subject. Peterson and Peterson (1959) noted that the acquisition of verbal habits depends on the effects of a given occasion being carried over into later repetitions of the situation, with short-term retention an important aspect of this process. It has been suggested that the capacity for remembering sequences of information is a necessary condition for learning language, both for speaking (Flavell, Beach, and Chinsky, 1966; Carrow 1968) and for reading (Senf and Feshbach, 1970; Fillmer and Linder, 1970; Carroll, 1972; Haltom, 1970). Repetitions of short-term exposure to the same items, for example, names of birds, increase recall in

the short-term memory and facilitate retrieval from "permanent storage," or long-term memory; short-term retention, and retrieval from permanent storage, interact with language learning (Buschke in Deutsch and Deutsch, 1975). Yet another dimension of short-term memory vital to language learning is rhythmic temporal sequence information, required to distinguish between phonemes, words and phrases (Withrow, 1968).

Although short-term memory and long-term memory may interact closely in their relation to learning, most investigators contend that there is a real though vaguely defined and incompletely understood difference between the two. The suggestion that short-term memory and long-term memory are two distinct processes is based on electrophysiological and behavioral considerations. Larry R. Squire (Squire in Deutsch and Deutsch, 1975) has reviewed several models supporting a distinction between short-term and long-term memory on a physiological basis: First, manipulations designed to interrupt electrical activity in the nervous system, like electroconvulsive shock, disrupted memory only when the treatment was administered soon after training, with progressively less effect as intervals after training were progressively longer; second, inhibition of protein synthesis impairs expression of memory within minutes after training, suggesting that information depends partially upon a protein-synthesis-dependent information-storage process by

this time; third, amnesia has been produced by drug injection, suggesting that locus of memory shifts from the sub-cortex to the cortex as time increases; fourth, several physiological mechanisms with the potential to alter synaptic connectivity support the hypothesis that short-term memory may be related to pre-synaptic inhibition. Although much of this evidence is inconclusive, the body of results taken together strongly suggests that memory does depend on separate biological processes at different times after exposure to stimuli.

Behavioral evidence is also cited in support for separate storage in short-term and long-term memories. A sharp distinction is of course impossible, but the demonstration of rapid retention losses over short intervals of time has given impetus to the advocacy of dual-process models. The following are some features of short-term memory exemplified in the research: The amount of material to be recalled is considerably less than that remembered in long-term memory, with retention of single items rather than lists of items; the rate of forgetting is rapid; retention intervals are brief. (Postman and Keppel, 1970; Keppel and Underwood, 1962). In a study by Baddeley the further distinction was made that acoustic similarity interferes with short-term memory whereas semantic similarity interferes with long-term memory. Memory is presumed to depend exclusively on the short-term process for only a few minutes. Performance

should be impaired beyond this interval if the long-term process does not develop.

The nature of short-term memory storage has been found to change with the child's development. As the child's age increases, so does his short-term memory span for auditory and visual material (Carroll, 1972; Boswell, Sanders and Young, 1974; Hallahan, Kauffman, and Ball, 1974) up to a postulated adult capacity of seven units of information (Miller, 1956). This increase has been attributed to qualitative changes in the organization of incoming stimuli. In a task of visual sequential memory, it was found that four-year-old children could match sequences, but could not internally construct or maintain them without perceptual support, whereas at ages five and six most children were successful at recalling sequences. (Pufall and Furth, 1966).

Differences in type of material best recalled by different age groups may reflect changes in organization of recall material with age. Recall lists of pairs associated by rhyming, syntax, clustering, or serial ordering were presented to subjects age 2, 3, 4, and 5 with the following results: best recall for children age 2 was for rhyming words (concrete response to the sound of words), for age 3 syntactic (chaining based on the order in which words follow each other in language), for age 4 clustering (grouping of words into a learned category or concept, and for age 5 serial ordering. The authors suggested that these differences

can be described as a development from concrete to abstract functioning and from perceptual to conceptual responding (Rossi and Wittrock, 1973). Piaget also noted that the memory of children is bound up with the way in which they interpret stimuli, in short, with organization (Piaget and Inhelder, 1973), and others further contended that the adults' reorganization of stimuli in a systematic manner is associated with their superior level of short-term memory (Scribner and Cole, 1972; Haith, Morrison, Sheingold, and Mindes, 1970; Miller, 1956; Morin, Hoving, and Konick, 1970). Results of an experiment in which children age 5, 8, and 11 and adults recalled geometric forms at variable intervals after array offset indicate that age-related differences in performance concern processing stages, not intake capacity. While the study suggested that there are no differences in initial intake capacity for visual information, there was a large difference between the 5-year-olds and the other groups for recall accuracy at a 250 msec delay. Also, between 500 and 1000 msec the 11-year-olds and adults improved in accuracy, while the 5 and 8-year-olds decreased in accuracy. These results suggest that the older groups employed an active encoding strategy that the younger subjects could not or did not use (Sheingold, 1973).

Studies to measure average short-term memory span have typically employed digits or single words for the auditory modality, with 7 digits considered the average

adult span (Gates, 1916; Miller, 1956). For the visual modality, geometric forms and familiar pictures of objects have been presented to test recall, with an average recall of 2.73 items reported for children age 2 to 5 (Flavell, Beach and Chinsky, 1966) and a recall of 8 items for adults (Gates, 1916). The above figures are not to be considered standard for all conditions, as several factors have been shown to variably affect retention:

1. Familiarity. Familiar words and syllables and concrete nouns have been shown to be more easily remembered than the unfamiliar and abstract ("concrete" being those whose reference to objects, to material, to sources of sensation is relatively direct) (Lindley, 1960; Gorman, 1961; Peters, 1936).
2. Presentation. Presentation rate of 60 units/minute elicited memory better than a rate of 120 units/minute, for simple visual material, particularly with retardates. The slower rates were thought to allow for optimum encoding strategies (Gordan, 1968).
3. Practice. Increased practice has been shown to improve short-term retention of visually presented digits (Headrick and Ellis, 1964).
4. Duration of presentation. Increased visual stimulus duration positively affects retention when stimulus intensity remains constant (Gordan and Bush, 1968).
5. Delay between stimulus and required response. Shortest delays between presentation and response elicited optimum performance (Headrick and Ellis, 1965).
6. Activities during the retention interval.

Verbal rehearsal has been shown to increase memory (to be discussed in detail later), while unrelated "filler" material in the interval decreased retention (Peterson and Peterson, 1959). Retarded children perform short-term memory tasks in a manner not significantly different from normal children of the same mental age (Calfee, 1970). The performance of retardates of low socio-economic status was shown to be better than retardates of high socio-economic status on a task of visual short-term memory of digits (Orn and Das, 1972).

Some interest in short-term memory has developed to assess the comparative strengths of auditory and visual presentations. Senf and Feshbach (1970) simultaneously presented an auditory and a different visual stimulus to culturally deprived, dyslexic, and normal readers, with the results that younger children and dyslexic children tended to remember by modality, while older and culturally deprived children remembered by presentation pairs. All three groups made fewer errors in digit recall with the auditory than with the visual presentation modality. (Response modality was oral for both stimulus modalities.) Another study comparing auditory, visual and simultaneous auditory-visual presentations of common objects, digits, and colors using low socioeconomic status Negro second-graders as subjects sound results contradictory to the Senf and Feshbach study. These children were found to perform better (remember more

easily) with the visual and auditory-visual presentations than with the auditory presentations. This study seemed to support the authors' hypothesis that the visual modality is most basic to short-term memory, but failed to confirm the hypothesis that the auditory-visual channel was optimum for learning (Fillmer and Linder, 1970). Further evidence supportive of the view that the visual mode is the more effective comes from a study of undergraduate college students who were presented lists of three letter words auditorily and visually (Franklin and Weisiger, 1968). Arguing for the superiority of auditory presentation was Kroll, who defended its superiority whether procedures employ free or serial recall (Kroll in Deutsch and Deutsch, 1975).

Apparently recall is best when material is presented through the modality which the subject says he prefers and worst when presented through the nonpreferred modality (Daniel and Tacker, 1974). The development of the ability to encode, store, and retrieve verbally or visually presented material when the modality was uncertain was studied in kindergarten and 4th grade children, with the result that the modality to which the probe is presented did not significantly influence overall recall accuracy, regardless of presentation modality. Children as young as age five are apparently able to transfer across modalities (Hoving, Konick, and Wallace, 1975). Wallach and Averbach (1955) asserted that mode of presentation should be considered in

light of the psychological processes involved. For example, when a subject is visually presented with a nonsense syllable, he may not only see it, but pronounce it silently, so that two psychological processes then result from one objective event.

Modality, then, is a highly salient stimulus dimension for use as an organizational device. The question of superiority of visual or auditory memory has not been given a general answer covering all conditions and types of subjects.

Substantial research has studied the effect of verbal rehearsal, or medication, on short-term memory. A study of children in kindergarten, first, second, third, and fifth grades indicated that verbal labeling facilitated short-term memory performance for subjects in the intermediate age range, but not for the youngest and oldest subjects (Hagen and Kingsley, 1968). A nonverbal visual recall task for six and seven-year-olds indicated that those children who were observed to verbally rehearse had significantly better recall than those who did not rehearse (Keeney, Cannizzo, and Flavell, 1967). Labeling was further found to increase retention of four-year-olds (Wilgosh, 1975), five and eight-year-olds and adults (Morrison, Holmes, and Haith, 1974), college sophomores (Jenkins, Neale, and Deno, 1967), elementary children (Sabo and Hagen, 1973); Hagen, Hargrave and Ross, 1973; Durtz and Hovland, 1953;

Davies, 1972). Flavell, Beach, and Chinsky (1966) offer several explanations for verbal rehearsal: 1. The subject goes beyond the information given to transform a visually perceived sequence into a sequence of vocal responses, a self-generated cognitive strategy; 2. The subject demonstrates a capacity for sustained attentional focusing in the absence of perceptual support for doing so; 3. Coding and rehearsal represent a systematic plan for coping effectively with the task requirements; 4. A future-directed effort is represented on his part.

Nature of mediational activity can vary from individual to individual as to type favored for any given modality. For example, children with high visual imagery are better than their low-imagery peers at reproducing a visual stimulus from memory. In short, mnemonic mediation subsumes a long and heterogeneous assortment of cognitive representational activities (Reese and Lipsitt, 1970).

Summary

Short-term memory skills are necessary for verbal learning. These skills in children increase with age, and are found to change qualitatively as well as quantitatively. Adults appear to be more skilled at encoding the incoming stimuli in an organized manner than are children.

Investigation of preferred stimulus modalities has produced contradictory evidence; modality efficiency is subject to variation depending upon a number of factors.

Verbal mediation has been shown to generally improve short-term retention. Little is known, however, of the effects of pairing various stimulus modes, specifically auditory and visual, with various response modes, oral and gestural.

Purpose of the Study

Language reception is strongly dependent upon an adequate memory of words and their referents. Some aspects of various stimulus inputs and their effects on short-term memory have been considered, but little is known of the relative efficacy of auditory and visual inputs paired with various response modes to facilitate short-term memory. For example, some people may remember instructions better if they read them, others if they hear them; these same people may remember to different degrees if they then write down the instructions or repeat them to themselves. As yet the effectiveness of combinations of various stimulus-response combinations has been little studied.

This study was intended to measure short-term memory as various modes of stimulus and response are combined, to observe the possible advantage of some methods over others. The results may prove useful to the elementary school teacher in presenting instructions most effectively, to help her students remember and follow directions.

Chapter 2

PROCEDURES

Research investigating modality of stimulus presentation and response has a notable lack of information of their effect on short-term memory. In this study an attempt was made to investigate the comparative strengths of the auditory and visual modalities as they were paired with oral and gestural response modes.

Subjects

The sample consisted of 54 subjects. Variables to be controlled included:

1. Age: S's were in the 2nd grade and were within 12 months of age of each other.
2. Vision: S's had passed the school screening test of visual acuity.
3. Hearing: S's must have passed an audiometric screening test at 15 dB for 500, 1000, and 2000 Hz.
4. Intelligence: S's will be in the mid-70% intelligence range, as judged by 2nd grade teachers. The examiner showed each teacher a bell-shaped curve and indicated that only students in the mid-70% range of intelligence were wanted for the experiment. Formal intelligence tests were not used. The teacher's judgment

was accepted as to which of her children qualified. A teacher's typical response might be, "Oh, you wouldn't want these kids, they're too bright, and these are slow, so you'd better not take them, either. I think the rest are what you want." Children were chosen from a total of four classrooms, with each classroom teacher indicating to the examiner which children were in approximately the mid-70% range of intelligence.

5. Sex: Subgroups consisted of equal numbers of male and female S's.

Materials

Auditorily presented test stimuli consisted of ten nouns from the Thorndike-Lorge list of the 1,000 most common words (Thorndike and Lorge, 1944) and were included in the test items of the Photo Articulation Test photo cards (Pendergast, Dickey, Selmar, and Soder, 1969). The ten nouns were: cup, chair, table, fish, dog, cat, book, shoe, baby, and bed. Visually presented stimuli consisted of ten, individual, colored 2" x 3" photographs, each depicting one of the nouns auditorily presented.

Test words are combined randomly for the test trials. The order of test items remained constant from subgroup to subgroup. See Appendix A for a list of the test items.

Testing

Organization. Subjects are randomly divided into 3 groups, with 18 children in each, to receive one of 3 presentation modes: 1. Auditory, 2. Visual, 3. Auditory-Visual.

Each of the 3 groups assigned a particular mode of presentation consisted of 3 subgroups of 6 subjects each, randomly assigned. Each subgroup received a different order of use of the three response modes (Oral, Gestural and Oral-Gestural). Thus S's were administered 3 equivalent tests of short-term memory such that a particular mode of presentation was combined with every mode of response.

Familiarization. Each subject was familiarized with the test material. The child named each picture of the test stimuli; if an S' could not name a picture, it was named by the Examiner and presented again after the subject had named several other pictures to insure familiarity with each item. However, every subject was able to name the pictures upon the first exposure to them. Before initiation of the test, each subject was administered a pretest for training. The Examiner instructed: "I am going to show you some pictures, and I want you to remember them. After I show them to you, we'll see if you can find them again." The Examiner then displayed two of the test stimuli one at a time for one second each, returned the photo cards to the entire set, shuffled them to approximate random distribution, and placed

each card in the set face up in front of the S. The Examiner then instructed, "Now, point to the first picture you saw, and then to the second picture." (Or, depending upon the particular test combination, the Examiner might have said, "I will say some words, and I want you to show them to me and say their names exactly as I said them," and so on, with the instructions appropriate to a particular test combination.) The subject then was to indicate, in correct sequence, the two pictures which had been presented to him or the two words which had been said to him or both pictures and words. When the child responded correctly, the Examiner says, "That's right! You heard me say (or "you saw," etc.) 'chair-shoe.' Now let's try some more." The Examiner proceeded to administer the test. If the child failed to understand or follow directions, the Examiner was to demonstrate the desired behavior; every child was demonstrated understanding of the task after the pretest.

Test Administration. Instructions and procedures of the tests varied according to the stimulus-response mode combinations. Specific description of each test was classified below by presentation mode and subclassified by response mode.

1. Auditory. The Examiner instructed, "I am going to say some words, and I want you to say them after me," (or ". . . show me their pictures," or ". . . say them after me, and show me their pictures,) "just as I say them." The words were presented at the rate of two/second. The Examiner began with presentation of a two word series, then three, and so on, giving the subject encouragement to continue. The Examiner administered the first trial of a series until the subject failed to respond correctly at that level (# of stimulus words); at that point the second trial of the same level was also administered (see Appendix A).

The following methods were employed for response mode:

a. Oral: The child was to respond with simple naming of the stimuli presented to him by the Examiner.

b. Gestural: Pictures of the stimuli were placed before the subject; the subject was to point to the appropriate pictures in the order in which they had been presented.

c. Oral-Gestural: Operations proceeded as in the oral mode of response, except that the subject named the picture and pointed to it.

2. Visual. The child was shown pictures on individual 2" x 3" photo cards, displayed one at a time at the rate of one per second, and beginning with 2 cards in a series,

then three, four, and so on. The Examiner gave the following instructions: "I am going to show you some pictures. Then I will show you lots of pictures--you point to the pictures that I showed you. Point to the first picture you saw first. Here they are." The Examiner displayed the pictures. The pictures were removed, shuffled with the others, and the entire set of cards displayed. The Examiner then requested, "Now show (tell, or show and tell) me what you saw." Each succeeding presentation of cards was accompanied by the instructions, "Look carefully . . . Now show (tell, or show and tell) me what you saw." When a child failed to correctly indicate each of the cards displayed in Trial 1 of a series, the second trial was also administered. Testing was discontinued when the child failed to indicate correctly the pictures on both trials of a series.

Modes of response in combination with the visual presentation proceeded as in "Auditory" above.

3. Auditory-Visual. Method proceeded as in the visual mode, except that the pictures presented were accompanied by the naming of them by the Examiner.

For each mode of response, the procedure outlined in "Auditory" above was followed.

TABLE I
Summary of Experimental Design

	Subgroup A (Order 1)	Subgroup B (Order 2)	Subgroup C (Order 3)
Group 1	Train	Train	Train
Auditory	Test 1;oral response	Test 1;gestural response	Test 1;oral-gestural response
Presentation	Test 2;gestural response	Test 2;oral-gestural response	Test 2;oral response
	Test 3;oral-gestural response	Test 3;oral response	Test 3;gestural response
Group 2	Train	Train	Train
Visual	Test 1;oral response	Test 1;gestural response	Test 1;oral-gestural response
Presentation	Test 2;gestural response	Test 2;oral-gestural response	Test 2;oral response
	Test 3;oral-gestural response	Test 3;oral response	Test 3;gestural response
Group 3	Train	Train	Train
Auditory-Visual	Test 1;oral response	Test 1;gestural response	Test 1;oral-gestural response
Presentation	Test 2;gestural response	Test 2;oral-gestural response	Test 2;oral response
	Test 3;oral-gestural response	Test 3;oral response	Test 3;gestural response

Scoring

The following scoring system was employed:

2 points given for a correct response in the first trial in a series

1 point given for a correct response in the second trial in a series

0 points given for no correct response in the series

Design

A three-factor analysis of variance design, Type III (Lindquist, 1953), was used to test the possible significance of three main effects and their interactions:

1. Input - Stimulus Mode
2. Output - Response Mode
3. Order
4. The 2 and 3-factor interactions

Chapter 3

RESULTS

Tests of short-term memory were administered to 54 second-graders with normal intelligence, vision and hearing to determine the effects of various presentation and response modes on short-term memory span. The children were between the ages 7 years 4 months and 8 years 7 months. Each child was given three tests of his short-term memory span; the mode of material presentation was the same for an individual child (auditory, visual, or auditory-visual), but the mode of response changed for each of the three tests (oral, gestural, oral-gestural).

The purpose of this study was to investigate the effects of three presentation and three response modes on short-term sequential memory in children. Children's sequential memory scores obtained under each presentation, response and order condition were analyzed using a split plot S-factor analysis of variance procedure. The analysis was calculated by means of a computer program which computes the probability of the F ratio to five decimal places. The results of this analysis appear in Table 2.

The analysis involved a consideration of three main effects (order, presentation mode, and response mode) and

four interactions. The results of the analysis of variance, summarized in Table 2, indicate that mode of presentation is the most powerful extrinsic variable in determining the length and accuracy of response in the short-term sequential memory tests given. Neither the order of the three tests given to a child nor the response mode seemed to influence the length of response (except in presentation-response interaction). Response mode did seem to have some effects on test results in interaction with the mode of presentation.

Table 2
Summary of Analysis of Variance on the
Short-term Memory Tests

	Sums of Squares	Mean Square	DF	F Ratio	Prob.
Order	5.64198	2.82099	2	0.511	0.57438
Presentation	221.642	110.821	2	22.413	0.00001*
Response	0.901325	0.450617	2	0.415	0.66718
O-P	7.87654	1.96914	4	0.398	0.81043
O-R	4.39506	1.09877	4	1.013	0.40618
P-R	11.2839	2.2099	4	2.600	0.4065*
O-P-R	14.4198	1.80247	8	1.661	0.11856
Error b	222.500	4.94444	45		
Error w	97.6667	1.08519	90		

*Significance at the 0.5 level of confidence or beyond indicated.

Statistically significant differences are indicated between the means of the scores on the presentation modes.

Scheffe contrasts were computed for the presentation means; overall scores proved to be best when the auditory presentation was used. Differences between scores of the auditory-visual presentation mode and the visual presentation mode were not significant, although for the subjects in this experiment, the auditory-visual presentation mode was slightly more effective. Differences between the auditory mode and both the visual and the auditory-visual modes were statistically significant, as determined by the Scheffe contrasts. Despite the presence of presentation-response interaction, the three modes of presentation always ordered themselves the same way regardless of response mode or order of presentation. Means for the presentation and response effects are listed in Table 3, as well as means for all presentation-response combinations.

Table 3

Means for Presentation and Response Effects
and all Presentation-Response Combinations

Response	Presentation Modes			Response Means over all Presentations
	Auditory	Visual	Aud-Visual	
Oral	8.55556	5.05556	6.50	6.70370
Gestural	8.38889	5.66667	6.11111	6.72222
Oral-Gestural	7.72222	5.50	6.16667	6.55556
Presentation Means over all Responses	8.22222	5.40741	6.35185	

Evaluation of differences between pairs of the means of the presentation-response mode combinations revealed no statistical differences when pairs of treatment combinations were compared across the response modes. As would be expected in view of the significant F., for presentations differences did occur between pairs of treatment combinations when these were compared across presentation modes. Differences between mean scores of the following treatment combinations were significant at the .05 level of confidence, using Scheffé contrasts: auditory-oral/auditory visual-oral, auditory-gestural/visual-gestural, auditory-oral/visual-oral, auditory-gestural/auditory visual-gestural, auditory-oral gestural/visual-oral gestural. In each pair the modes of presentation are varied and the response mode remains the same; the auditory mode of presentation is the more effective in each comparison pair.

Responses were generally most effective when paired in the same sensory-motor "channel" with presentations; that is, the oral response paired with the auditory presentation was more effective than were the oral-gestural and gestural responses paired with auditory presentation. Similarly, the gestural response paired with a visual presentation was more effective than the oral and oral-gestural responses. When the presentation combined auditory and visual modes, the best response mode was again the oral, perhaps suggesting that the auditory-oral channel is the greater influence

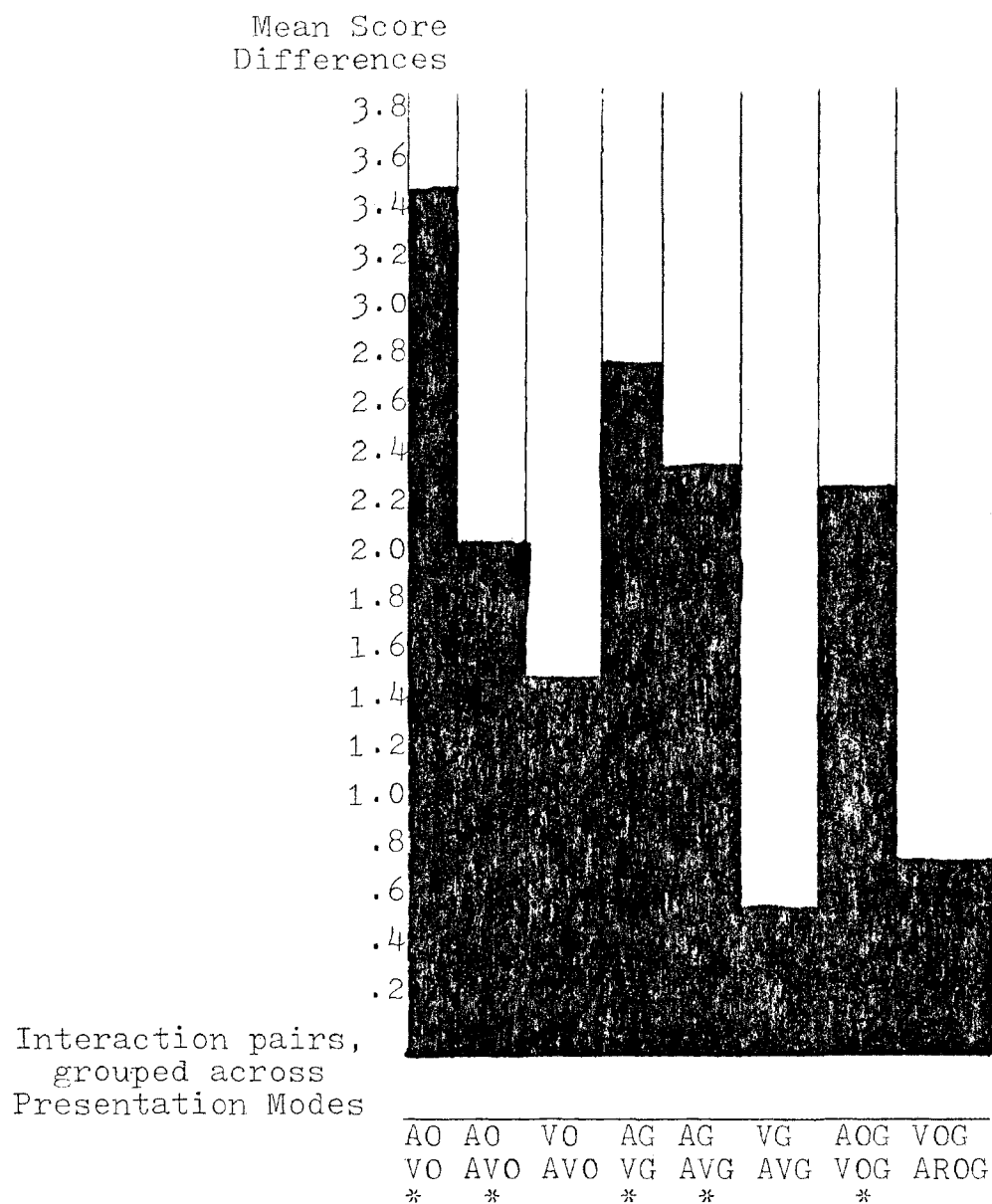
on short-term sequential memory. (Refer to Figures 1a and 1b.) These differences were not statistically significant at the 0.5 or at the .10 level of confidence but will perhaps excite enough interest that future researchers may investigate further and discover significant differences between various stimulus and response mode treatment combinations.

When presentation-response mode combinations were compared across presentation modes, some statistically significant differences did occur. Each of the three response modes was more effective when combined with the auditory than with the visual presentation. In addition, the gestural response mode was significantly better when paired with the auditory presentation mode than with the auditory-visual. These results might be expected from the mode of presentation means discussed earlier, in which the auditory presentation mode was always superior to the other modes of presentation. Presentation-response interaction comparisons add to the evidence that auditory presentation was the most effective presentation mode across all response modes.

Scheffe contrasts indicated that scores were significantly better for every response mode combined with the auditory mode of presentation. In addition, the gestural response mode yielded better scores when paired with the auditory mode than with the auditory-visual mode of presentation.

Figure 1a

Mean Differences Between Scores on Short-term Memory Tasks
Between Presentation-Response Mode Combinations
Across Response Modes



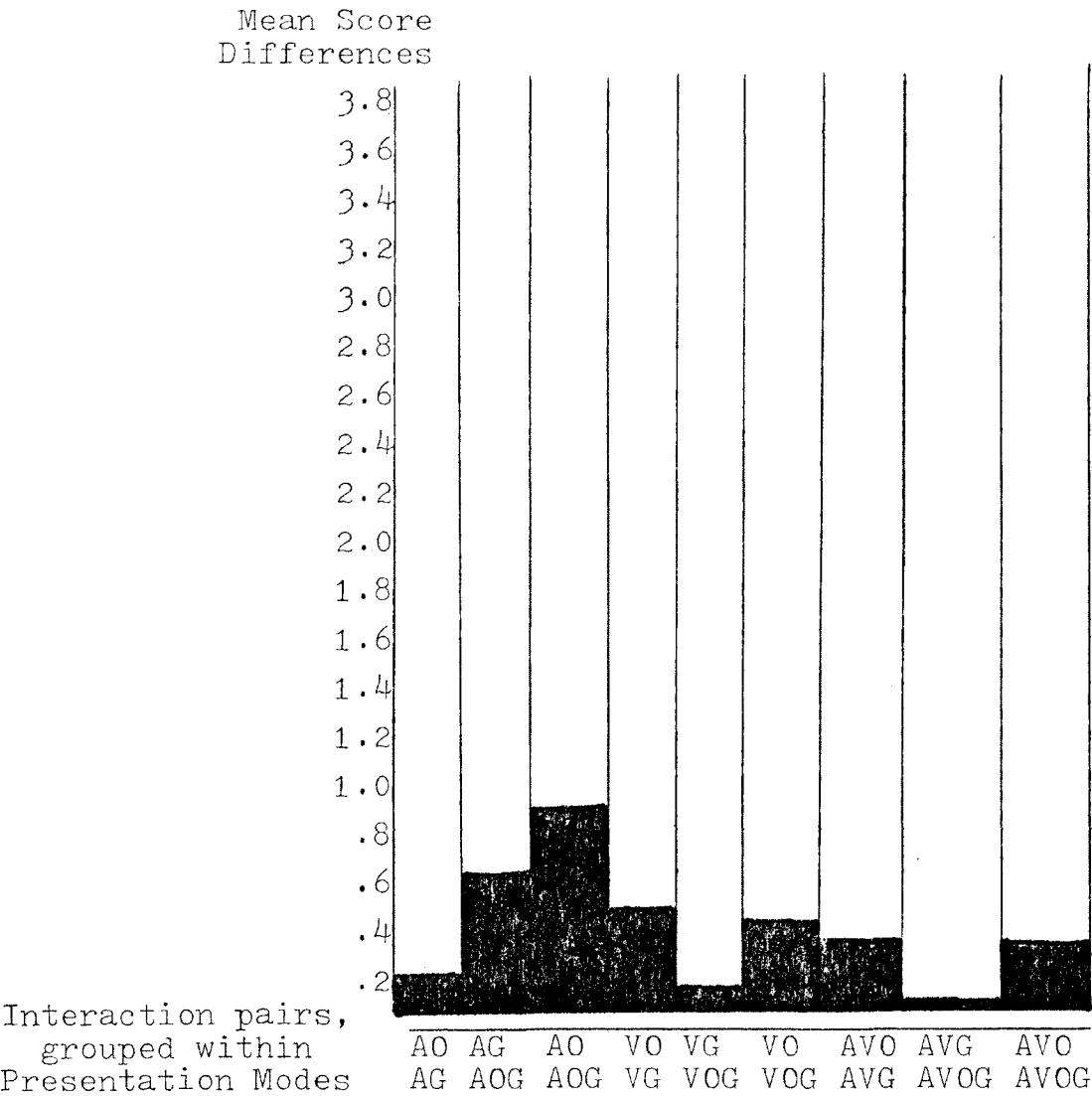
Key

A - Auditory Presentation Mode	O - Oral Response Mode
V - Visual	G - Gestural
AV - Auditory-Visual	OG - Oral Gestural

*Differences significant at the .10 level of significance, using Scheffe contrasts.

Figure 1b

Mean Differences Between Scores on Short-term Memory Tasks
Between Presentation-Response Mode Combinations
Across Response Modes



Key

A - Auditory Presentation Mode	O - Oral Response Mode
V - Visual	G - Gestural
AV - Auditory-Visual	OG - Oral Gestural

Chapter 4

DISCUSSION

The purpose of this study was to examine the effects of various modes of presentation and various modes of response on the short-term sequential memories of second-graders, with a view to helping the primary school teacher in giving most effective instructions. It was thought that the study could be a resource for the speech and language clinician whose young client has difficulty remembering instructions.

The results of this study indicate that the mode of presentation of material significantly effects the length and accuracy of short-term retention. Material presented auditorily elicited the longest and most accurate responses; the auditory-visual mode and the visual mode were not significantly different in effectiveness. Varying the mode of response and the order of response mode did not alter the short-term memories of these second-graders, except in interaction with the mode of presentation.

There are several factors which may account for these results: 1) the auditory presentation may have forced verbal labeling (or mediation) regardless of response mode; 2) the method of presenting materials in this testing

situation may have inherently favored the auditory mode;

3) presentation and response modes in the same sensory-motor "channel" may require less mental processing and be more quickly stored into short-term memory than presentation and response modes from two differing sensory-motor channels.

Verbal Labeling. The contention was noted in the beginning of this study (Hagen and Kingsley, 1968; Deeney Cannizzo and Flavell, 1967; Morrison, Holmes, and Haith, 1974; Sabo and Hagen, 1973; Durtz and Hovland, 1953; Davies, 1972) that verbal labeling facilitated short-term memory performance in elementary children. Presentation of material by the auditory mode in this study automatically supplied the child with a verbal label, which he could retain and use to guide his response. This label, perhaps, aided his short-term memory of the material. Children in this experimental condition were then, perhaps, relieved of the necessity for locating or for coining their own labels for retention and response-selecting purposes. One child, for example, asked the Examiner, "Is that a baby?", pointing to a stimulus picture. Apparently he was labeling pictures as they were presented to him.

Differences between methods of presentation. The second factor which may account for the significant differences between means of the presentation modes may be the difference in method of presentation of these modes.

Material presented auditorily was presented at the rate of 2 words/second, while visual material was presented at the rate of 1/second. The shorter time between presentations of auditory stimuli may have lessened the length of time that the set of stimuli must be remembered, and thereby increased the child's short-term memory span for the auditory mode. In contrast, it is possible that the longer duration of a set of stimuli presented visually or auditorily-visually increased the time over which it had to be retained, and consequently were accompanied by a shorter short-term memory.

Within the present study there is evidence bearing on this last hypothesis and tending to contradict it. In general, the children could respond more rapidly via the oral response mode than via the gestural mode, and the oral-gestural response mode was not appreciably slower than the gestural. However, auditory presentation yielded better short-term memory scores regardless of whether or not it was paired with a response mode that required more time. In the same way, the visual-oral presentation-response combination took less time but was less effective than the visual-gestural combination. In short, although length of presentation may have affected the short-term memory scores because of the varying time that the child had to retain material, length of response time did not seem to affect the results. It is therefore questionable whether overall

length of time from presentation through response significantly affected the short-term memory scores.

Sensory-motor "channel". A third possible factor explains the presentation-response interaction in which the auditory mode of presentation is best when paired with the oral mode of response, and the visual presentation mode is best with the gestural response mode. The effectiveness of these "hear-speak" and "see-point" combinations may be attributed to conditioning (if one hypothesizes that the channel through which most human communication is transmitted and received would be the best facilitator of short-term memory) or to innately favored channels. Osgood (Carrow, 1968) hypothesized a model of information retention in which material presented and responded to in the same "channel" is retained more easily than material whose presentation and response modes cross channels.

A similar hypothesis has been presented by George Ettlinger in "Analysis of Cross-Modal Effects and Their Relationship to Language" (Millikan and Darley, Ed., 1967). He suggests that a separate neural system is concerned in the recognition of a particular object through each sense modality, and that each of these systems is connected to a single further system (presumably in the speech areas) concerned with the equivocation of the name of the object. In his experimentation and review of similar experimentation

cross-modal transfer of a specific discrimination habit was not demonstrated in man or animal. He implies that learning a discrimination task via the same mode is phylogenetically earlier and more efficient than learning the discrimination across sensory modes. Apparently cross-modal presentation of sensory material induces less effective storage than does same-modal presentation.

Mr. Ettlinger's paper did not include studies on the modes of response. However, the existence of separate sensory-motor neural systems for presentation mode-response mode combinations, or channels, such as auditory-oral and visual-gestural channels, learned or innate, may be hypothesized, and could be a possible explanation for the results of this study.

From the diversity of results in past research, it seems evident that short-term memory will vary with varying of specific conditions--type and difficulty of material, duration of presentation, age of subjects, and so on. The literature differs on the comparative values of auditorily and visually presented material, and, while this study adds support to those studies suggesting that the material is best remembered when presented auditorily, the difference favoring auditory presentation is not overwhelming and the evidence is by no means conclusive.

Results from this study would seem to indicate that the second-grade teacher should give directions auditorily,

not relying heavily on visual instructions. A clinician working with a child who demonstrates short-term memory problems may want to test him using various modes of stimulus presentation and response to discover which modes elicit the best memory from him; she should probe his individual memory abilities as well as acquaint herself with relevant literature as she plans remediation. Becoming aware of the child's specific abilities would also help the clinician to advise the classroom teacher as to best modes of direction-giving and response-eliciting. Greater effectiveness of some input-output pairs may tend to differ from child to child. Testing children with processing problems might reveal presentation and response modes in which their processing problems are less pronounced.

The results of this study suggest that at least with single-word stimuli and responses, varying modes of presentation and response may elicit varying lengths of short-term memory. It seems that this area of study warrants further investigation; perhaps a study of use of actual visual and auditory commands combined with gestural and oral responses would further aid the speech clinician seeking information relevant to her young clients' needs.

Chapter 5

SUMMARY AND CONCLUSIONS

An investigation was made to determine the effects of various presentation and response modes on short-term sequential memory in second graders. The study examined the effects of three modes of presentation (auditory, visual, and auditory-visual) as combined with one of three modes of response (oral, gestural, and oral-gestural). Subjects were divided into three groups, the children in each group receiving three tests of short-term memory span. The mode of material presentation was the same for an individual child, but the mode of response changed for each of the three tests.

The 27 girls and 27 boys in the study, selected from two of Missoula's parochial schools, all successfully responded to an auditory screening test at 15 dB at 500, 1000, and 2000 Hz, passed the school's visual screening, and were in the mid-70% intelligence range, as judged by the second grade teachers.

The results obtained were evaluated by means of a three-factor analysis of variance design, Lindquist Type III. Scheffe contrasts were computed where significant differences were indicated between means. Analysis of test

results indicated statistical significance between the means of the scores of presentation modes; scores were highest with the auditory mode of presentation, second highest with the auditory-visual mode, and least high with the visual mode. (Differences between the latter 2 were not significant.) There were no significant differences either between means of test scores of the response mode or between scores of the varying orders of the three tests given to a child. Some statistically significant differences occurred when presentation-response modes were compared; the three response modes were more effective when combined with the auditory than with the visual presentation, and the gestural response was significantly better when combined with the auditory presentation mode than with the auditory-visual.

CONCLUSIONS

Recognizing the limitations of this investigation and the caution required in generalizing the results to other populations, the data suggest the following conclusions:

1. The auditory mode of presentation of material appears to be more effective at increasing the short-term memory of second graders than are the visual and auditory-visual modes of presentation.
2. The modes of response would tentatively appear to

be most effective when paired with a presentation mode of the same sensory-motor "channel" (for example, oral-auditory, gestural-visual).

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APPENDIX A

STIMULUS WORDS FOR THREE ORDERS

Trial I

- I. - book fish
 - chair bed table
 - cup fish bed chair
 - baby table car fish shoe
 - dog car baby cup book fish
 - book car fish table cup bed chair
 - fish baby car book chair cup shoe table

- II. - book car
 - chair fish car
 - book chair table fish
 - cup book dog bed table
 - chair baby dog fish cup car
 - shoe cup bed fish chair dog baby
 - book chair table shoe dog baby car fish

- III. - fish baby
 - cup bed fish
 - dog baby cup chair
 - fish bed shoe chair baby
 - car bed table dog cup chair
 - bed car dog baby cup shoe table
 - car cup dog bed fish baby shoe book

PRETEST WORD PAIRS

- | | |
|--------------|--------------|
| - chair shoe | - chair fish |
| - car bed | - baby car |
| - fish cup | - fish bed |
| - car chair | - shoe dog |

Trial II

- I. - shoe bed
 - fish shoe book
 - car dog table fish
 - fish bed chair dog book
 - chair shoe car dog cup bed
 - chair baby cup table book fish shoe
 - baby book chair cup car shoe fish bed

- II. - baby dog
 - car cup shoe
 - bed car fish shoe
 - car chair fish dog baby
 - shoe fish table cup book baby
 - car chair table book fish cup shoe
 - car bed fish shoe dog cup book baby

- III. - cup car
 - table cup fish
 - baby car book dog
 - table book dog chair fish
 - chair bed book cup car dog
 - baby bed fish table chair cup car
 - bed book baby dog table fish shoe cup